Coastal Journal of Medical and Allied Health Sciences
E-ISSN: 3092-8834; P-ISSN: 3092-8842
Journal homepage: cm-journals.com

[Research Article]

Spectrum of Anti-Hypertensive Therapy in Tertiary Health Care Center of Rajasthan

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Published on 04 January 2025. Revised on 4th August 2025.

DOI: https://doi.org/10.5281/zenodo.16736849

Abstract:

Background:
Hypertension remains a major contributor to global cardiovascular morbidity and mortality. While current guidelines advocate for blood pressure (BP) control below 130/80 mmHg, achieving this target in clinical practice remains a challenge, particularly in resource-limited settings. This study aim to evaluate the spectrum of antihypertensive therapy and assess blood pressure response in hypertensive patients admitted to a tertiary care hospital in Rajasthan, India.

Methods:
A prospective observational cohort study was conducted on 222 hypertensive patients admitted to the Department of General Medicine at a tertiary care center. Patients were followed at baseline, 24 hours, 7 days, and 30 days. BP control was assessed using the revised threshold of 130/80 mmHg. Data were collected from case records and structured patient interviews. Descriptive and inferential statistics were used for analysis.

Results:
At recruitment, the mean systolic and diastolic BP were 165 ± 29 mmHg and 96 ± 17 mmHg, respectively. After 30 days, SBP and DBP decreased to 137 ± 14 mmHg and 84 ± 13 mmHg. However, only 8% and 40% of patients achieved target SBP and DBP control, respectively. The proportion of patients in hypertensive crisis dropped from 33% to 0%. Monotherapy was the most common regimen (54%), though no significant difference in BP control was observed across different treatment combinations.

Conclusion:
Despite short-term improvements in BP following antihypertensive therapy, the majority of patients did not achieve optimal BP control under the revised diagnostic threshold. These findings highlight the need for personalized treatment strategies, structured follow-up, and adherence to guideline-based therapy, particularly in high-risk tertiary care populations.

Keywords: Hypertension, Anti-Hypertensive therapy, Blood Pressure Control, Cardiovascular risk.

Introduction:

Hypertension remains a global public health challenge and a major contributor to cardiovascular morbidity and mortality. Despite the availability of effective pharmacological interventions and the establishment of international treatment guidelines, blood pressure (BP) control rates remain suboptimal, particularly in low- and middle-income countries (LMICs) (Schutte et al., 2022; Liu et al., 2021). Inconsistent BP control (<140/90 mmHg) is attributed to multifactorial issues including poor treatment adherence, inadequate patient counseling on adverse drug reactions (ADRs), and lack of patient involvement in therapeutic decisions (Liu et al., 2021).

Non-adherence is especially high in South Asia and Sub-Saharan Africa, where structural barriers such as physician shortages, one-month drug refills, and poor access to care contribute to high treatment dropout rates (Schutte, 2023; Galson et al., 2023). Clinical inertia and inadequate follow-up further exacerbate poor BP

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control, particularly when healthcare delivery is fragmented or limited to emergency departments (Galson et al., 2023).

Recent shifts in hypertension diagnostic thresholds from ≥140/90 mmHg to ≥130/80 mmHg aim to enable earlier interventions. However, these changes also impact the identification of at-risk populations and predictors of new-onset hypertension. Studies show that factors such as age, sex, BMI, fasting glucose, and triglyceride levels remain key predictors across both thresholds, although some variables like male sex and low eGFR show definition-specific significance (Y.H. Liu et al., 2022; Wang et al., 2021).

Pharmacologic management must balance efficacy with patient safety. Inappropriate polypharmacy, particularly in elderly patients, is a common issue that heightens ADR risk and impacts compliance (Shust et al., n.d.; Passarella et al., 2018). Clinical guidelines advocate for personalized treatment using RAS inhibitors, CCBs, or thiazide-like diuretics, especially in high-risk groups like diabetics (Passarella et al., 2018; ADA, 2023). Nevertheless, the translation of global guidelines to LMIC contexts is often ineffective due to population-specific differences in hypertension phenotypes and healthcare system limitations (Nugroho et al., 2022). In South and East Asia where over 44% of global hypertensive cases reside features like salt sensitivity and exaggerated morning BP surge demand region-specific strategies (Kario et al., 2020).

In light of these concerns, the present study seeks to analyze the spectrum of antihypertensive therapy in a tertiary care hospital in Rajasthan**,** with a focus on understanding treatment trends, patient response, and associated clinical outcomes. Specifically, we aim to evaluate prescription patterns, determine the common drug regimens used, assess patient response to treatment. By examining these parameters, this research intends to provide region-specific insights that can inform rational prescribing practices, improve patient safety, and enhance overall hypertension management strategies in tertiary care settings.

Methods:

Study Design and Setting

This was a prospective observational cohort study conducted over a period of three months in the Department of General Medicine at Ananta Institute of Medical Sciences and Research Centre, Rajsamand, Rajasthan. The institute, affiliated with the Rajasthan University of Health Sciences, is a 720-bed tertiary care hospital located approximately 20 km from Udaipur on National Highway-8. It offers a range of primary and super-specialty services including cardiology, nephrology, oncology, and neurosurgery.

Study Population and Eligibility Criteria

The study enrolled 220 adult inpatients (aged ≥18 years) who were admitted to the General Medicine department with a diagnosis of hypertension (systolic BP >140 mmHg and/or diastolic BP >90 mmHg), with or without comorbidities, and were receiving pharmacological treatment. The sample size of 220 was determined using statistical software (G*Power version 3.1.9.7), based on an anticipated effect size, 95% confidence interval, 5% margin of error, and 80% power. Pregnant women and individuals under 18 years of age were excluded from the study.

Follow-up and Data Collection

Participants were followed at four time points: baseline (0 hours), 24 hours, 7 days, and 30 days. Data collection included both retrospective extraction from clinical case records and prospective structured patient interviews. Case records were reviewed to obtain information on demographic characteristics, clinical diagnoses, prescribed antihypertensive agents, investigation results, comorbid conditions, and adverse drug reactions (ADRs). Additionally, patient interviews were conducted using a pre-validated semi-structured questionnaire to assess awareness of hypertension, lifestyle modification efforts, adherence to prescribed therapy, and understanding of medication purpose and side effects.

Measured Variables

The study focused on multiple outcome variables to comprehensively evaluate the spectrum of antihypertensive therapy. These included the proportion of patients achieving adequate blood pressure control, the frequency and type of antihypertensive drug regimens prescribed, the occurrence and pattern.

Data Analysis

All collected data were coded and entered using Microsoft Excel 365, and statistical analyses were performed using SPSS version 23. Descriptive statistics were used to summarize sociodemographic and clinical variables.

Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as means with standard deviations. The Chi-square test was employed to identify significant associations between categorical variables. Binary logistic regression analysis was conducted to determine independent predictors of blood pressure control, with a 95% confidence interval and a p-value ≤ 0.05 considered statistically significant.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee of Ananta Institute of Medical Sciences and Research Centre, Rajsamand. Written informed consent was obtained from all participants prior to their inclusion in the study.

Result

Table 1: Socio-demographic characteristics of the study participants

Variables	Frequency (N = 222)	Percent (%)
Age range		
20 – 29	3	1
30 – 39	7	3
40 – 49	40	18
50 – 59	58	26
>60	114	52
Mean ± SD	59.5 ± 11.85	
Sex		
Male	122	55
Female	100	45
Occupation		
Retired/Housewife	147	66
Famers	42	19
Laborer/Others	33	15
Marital status		
Married	173	78
Unmarried/Others	49	22
BMI		
Normal	153	69
Obese	69	31
Duration of Treatment		
Newly Diagnosed	71	32
< 1 year	84	38
1-5 years	67	30

Table 1 presents the socio-demographic characteristics of the 222 hypertensive patients included in the study. Of these, 122 (55%) were male and 100 (45%) were female. The mean age was 59.5 ± 11.85 years, with the majority (52%) aged over 60 years. The youngest age group (20–39 years) accounted for only 4% of the participants.

Regarding employment status, 66% were either retired or housewives, 19% were farmers, and 15% were categorized as laborers or engaged in other informal work. A substantial proportion of participants were unemployed. Most participants (78%) were married.

In terms of body mass index (BMI), 69% had a normal BMI, while 31% were classified as obese. With respect to treatment history, 32% were newly diagnosed with hypertension, 38% had been on therapy for less than one year, and 30% had been receiving antihypertensive treatment for 1–5 years.

Table 2: Distribution of Blood Pressure after 30 days follow up intervals and assessment of patient response to antihypertensive therapy according to type of treatment selected.

Treatment	**No. of Patients**	**DAY 0 Mean ± SD**		**DAY 30 Mean ± SD**	
Monotherapy		SBP	DBP	SBP	DBP
CCBs	27	138±20	81±12	136±10	82±8
ARBs	33	152±18	87±14.5	137±9	82±6
Diuretics	7	153±12	92±4	145±0	84±2
Dual Therapy					
ARB + Diuretics	20	167±19	96±15	139±9	83±9
ARB + CCB	44	160±24	91±10	137±7	80±6
ARB + β Blockers	7	141±14.5	78±15	134±5	77±5
CCB + α Blockers	4	164±21	100±15	134±5	85±8
Diuretics + Diuretics	4	135±7	90±0	125±7	80±14
Triple Therapy					
ARB + CCB + Diuretics	25	178±24	105±13	136±4	79+6
ARB + βB + Diuretics	4	193±21	113±21	160±0	112±0
ARB + βB + CCB	4	190±25	107±16	137±5	84±7
ARB + βB + α Blockers	4	220±0	120±0	148±0	85±6
Poly Therapy					
ARB + CCB + αB + Diuretics[2]	7	205±22	120±15	142±4	89±15
ARB + CCB + Diuretics+	7	167±49	103±9	140±16	90±10
Others	25	183±30	107±22	144±7	84±6

Table 2 displays blood pressure (BP) values at baseline (Day 0) and after 30 days of follow-up across different treatment regimens. Most participants did not achieve the target BP of <130/80 mmHg within this period. Only two patients, both on a diuretic-inclusive combination regimen, reached the target. However, as this subgroup included only four participants, the finding is inconclusive. A larger sample will be needed to evaluate therapeutic efficacy across drug classes more robustly.

Table 3: Distribution of Blood Pressure at different follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	DAY 0		24HRS		DAY 7		DAY 30	
SBP	Frequency (N=222)	%	Frequency (N=222)	%	Frequency (N=207)	%	Frequency (N=173)	%
<120 (Normal)	9	4	13	6	17	8	7	4
120-129 (Elevated)	2	1	9	4	27	13	7	4
130 – 139 (Stage 1)	31	14	27	12	42	20	93	54
140 > (Stage 2)	107	48	149	67	54	26	66	38
180 > (HTN Crisis)	73	33	24	11	67	33	0	
Mean ± SD	165±29		152±22		145±23		137±14	
DBP								
<80	31	14	44	20	51	24.5	69	40
80 - 89	51	23	53	24	72	35	55	32
90 - 99	62	28	67	30	49	23.5	31	18
>100	78	35	58	26	35	17	18	10
Mean ± SD	96±17		94±15		90±19		84±13	

Table 3 outlines BP distribution over time at four follow-up points. At baseline, the mean SBP was 165 ± 29 mmHg and DBP was 96 ± 17 mmHg. Only 4% had normal SBP, while 48% were in Stage 2 hypertension, and 33% were in hypertensive crisis (>180 mmHg). For DBP, 14% were within the normal range, while 35% were in hypertensive crisis.

24-hour follow-up showed a reduction in mean SBP to 152 ± 22 mmHg, with a modest decrease in hypertensive crises (from 33% to 11%). DBP decreased slightly to 94 ± 15 mmHg, with a small increase in patients achieving DBP <80 mmHg (from 14% to 20%).

By Day 7, the mean SBP was 145 ± 23 mmHg and DBP 90 ± 19 mmHg. Notably, 8% achieved normal SBP, and 24.5% achieved DBP control. However, 33% remained in hypertensive crisis for SBP, showing a fluctuating pattern of control.

By Day 30, among the 173 remaining participants, SBP further reduced to 137 ± 14 mmHg, and no patients remained in hypertensive crisis. More than half (54%) were in Stage 1 hypertension, and 4% achieved normal SBP. DBP decreased to 84 ± 13 mmHg, with 40% reaching controlled levels (<80 mmHg). However, 60% still did not meet target SBP or DBP thresholds.

These results demonstrate a progressive trend toward improved BP control, particularly in the reduction of hypertensive crises. Nonetheless, a substantial proportion of patients failed to reach optimal targets, indicating the need for intensified therapy or additional intervention.

Table 4: Distribution of Blood Pressure at 24 hours follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	DAY 0	24HRS	Test	P-

SBP	Frequency (N=222)	%	Frequency (N=222)	%	**Statistic**	**Value**
<120 (Normal)	9	4	13	6	t= -0.41	0.967
120-129 (Elevated)	2	1	9	4		
130 – 139 (Stage 1)	31	14	27	12		
140 > (Stage 2)	107	48	149	67		
180 > (HTN Crisis)	73	33	24	11		
Mean ± SD	165±29		152±22			
DBP					t=1.999	0.022
<80	31	14	44	20		
80 - 89	51	23	53	24		
90 - 99	62	28	67	30		
>100	78	35	58	26		
Mean ± SD	96±17		94±15			

Table 4 compares BP changes from Day 0 to 24 hours. The mean SBP decreased from 165 ± 29 to 152 ± 22 mmHg**,** but the change was not statistically significant (t = -0.41, p = 0.967). However, DBP showed a significant reduction, from 96 ± 17 to 94 ± 15 mmHg (t = 1.999, p = 0.022). This suggests an early therapeutic effect on DBP.

Table 5: Distribution of Blood Pressure at 7 days follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	**DAY 0**		**DAY 7**		**Test Statistic**	**P-Value**
SBP	Frequency (N=207)	%	Frequency (N=207)	%		
<120 (Normal)	9	4	17	8	t=0.042	0.677
120-129 (Elevated)	2	1	27	13		
130 – 139 (Stage 1)	31	14	42	20		
140 > (Stage 2)	107	48	54	26		
180 > (HTN Crisis)	73	33	67	33		
Mean ± SD	165±29		145±23			
DBP					t=1.473	0.026
<80	31	14	51	24.5		
80 - 89	51	23	72	35		
90 - 99	62	28	49	23.5		
>100	78	35	35	17		
Mean ± SD	96±17		90±19			

Table 5 shows BP values from Day 0 to Day 7 for 207 patients. SBP decreased to 145 ± 23 mmHg, but again the change was not statistically significant ($t = 0.042$, $p = 0.677$). DBP, however, reduced from 96 ± 17 to 90 ± 19 mmHg**,** which was statistically significant ($t = 1.473$, $p = 0.026$). The proportion of patients with DBP <80 mmHg increased from 14% to 24.5%, and those with DBP >100 mmHg dropped from 35% to 17%.

Table 6: Distribution of Blood Pressure at 30 day follow up intervals and assessment of patient response to antihypertensive therapy.

BP Category	**DAY 0**		**DAY 30**		**Test Statistic**	**P-Value**
SBP	Frequency (N=222)	%	Frequency (N=173)	%		
<120 (Normal)	9	4	7	4	t= -0.755	0.032
120-129 (Elevated)	2	1	7	4		
130 – 139 (Stage 1)	31	14	93	54		
140 > (Stage 2)	107	48	66	38		
180 > (HTN Crisis)	73	33	0			
Mean ± SD	165±29		137±14			
DBP					t= -1.582	0.118
<80	31	14	69	40		
80 - 89	51	23	55	32		
90 - 99	62	28	31	18		
>100	78	35	18	10		
Mean ± SD	96±17		84±13			

Table 6 presents final follow-up data at Day 30 for 173 participants. SBP decreased significantly from 165 ± 29 to 137 ± 14 mmHg ($t = -0.755$, $p = 0.032$), with the complete resolution of hypertensive crises (0% at Day 30 vs. 33% at baseline). DBP also declined from 96 ± 17 to 84 ± 13 mmHg, though the change was not statistically significant ($t = -1.582$, $p = 0.118$). However, clinical improvement was evident, with the proportion of patients achieving DBP <80 mmHg increasing to 40%.

These results confirm that antihypertensive therapy led to a statistically significant improvement in SBP after 30 days, while DBP improvement, though clinically meaningful, did not reach statistical significance. The findings highlight a need for more personalized or intensified treatment strategies to achieve comprehensive BP control.

Discussion:

Most hypertension studies have traditionally employed the 140/90 mmHg threshold for diagnosis and treatment targets, which has been the benchmark in major guidelines such as the JNC 7 and JNC 8 (Chobanian et al., 2003). However, more recent recommendations, including those from the American College of Cardiology/American Heart Association (ACC/AHA), advocate a lower threshold of 130/80 mmHg, with the goal of initiating earlier intervention and improving cardiovascular outcomes (Whelton et al., 2018). In this study, we adopted the revised definition of hypertension (≥130/80 mmHg) to evaluate blood pressure (BP) control in a cohort of 222 hypertensive patients over a 30-day period.

At baseline, the mean systolic blood pressure (SBP) of participants was 165 ± 29 mmHg, which progressively decreased to 137 ± 14 mmHg by Day 30. A similar trend was observed in diastolic blood pressure (DBP), which declined from 96 ± 17 mmHg at recruitment to 84 ± 13 mmHg after 30 days. While these reductions reflect a clinically meaningful improvement, only 8% of participants achieved the target SBP <130 mmHg, and 40% achieved DBP <80 mmHg, indicating that most patients remained above the revised control threshold.

The significant reduction in hypertensive crises (from 33% to 0%) over 30 days is encouraging and suggests that short-term antihypertensive therapy can be effective in preventing extreme elevations in BP. This finding aligns with previous reports that underscore the value of early and consistent treatment in reducing acute hypertension-related risks (Wang et al., 2021; Mills et al., 2020).

In terms of therapeutic strategies, monotherapy accounted for 54% of prescriptions, with calcium channel blockers (CCBs) being the most commonly used agents. Despite the availability of fixed-dose combination therapy which is generally recommended for patients with Stage 2 hypertension or BP >20/10 mmHg above target there was no significant difference in BP control among patients on combination versus single-drug regimens. This reflects a prescribing trend observed in previous studies conducted in India and other low-resource settings, where cost, adherence concerns, and physician preference contribute to a reliance on monotherapy (Ayuba et al., 2024).

While single-drug therapy may suffice in early or mild hypertension, multiple trials, including the SPRINT trial, have shown that combination therapy offers superior BP control and cardiovascular protection, especially in patients with comorbidities or elevated baseline BP (Wright et al., 2015). The continued preference for monotherapy, despite suboptimal target achievement, suggests a need for updated prescriber training and access to cost-effective combination drugs. Interestingly, DBP showed greater sensitivity to treatment than SBP, with 40% of participants achieving diastolic control compared to only 8% for systolic control. This asymmetry has been noted in other observational studies, where diastolic pressure often responds earlier and more consistently to therapy, particularly in younger individuals or those without stiff arteries (Tan et al., 2023).

Regression analysis confirmed a statistically significant reduction in SBP over the follow-up period ($p < 0.05$), while the reduction in DBP approached but did not reach statistical significance. These findings, though modest, underscore the short-term efficacy of antihypertensive drugs in real-world clinical settings. However, longer-term studies are required to evaluate whether these initial benefits can be sustained and whether they translate into improved cardiovascular outcomes.

Patient follow-up declined to 173 participants (78%) by Day 30, pointing to a common challenge in hypertension management poor retention and follow-up compliance. Multiple studies have reported high attrition in hypertension care, often linked to transport costs, low health literacy, side effects, and a lack of perceived benefit in asymptomatic conditions like hypertension (Galson et al., 2023). Addressing these barriers through patient-centered counseling, follow-up reminders, and community-level education may improve engagement and treatment outcomes. Moreover, the heterogeneous response to antihypertensive therapy in our cohort points to the need for personalized treatment strategies. Advances in pharmacogenetics and AI-assisted prescription modeling may provide avenues for improving therapeutic precision, particularly in diverse populations (Zappa et al., 2023; Liu et al., 2021). However, these innovations must be balanced with practical concerns of affordability and availability in low- and middle-income countries (LMICs).

These findings have practical relevance in guiding hypertension management under the revised 130/80 mmHg threshold. Despite clear improvements in systolic and diastolic pressure, most patients remained above target levels, highlighting both individual and systemic challenges in achieving optimal control. The persistence of monotherapy as the dominant treatment choice, despite evidence supporting early combination therapy for those with significantly elevated BP, reflects both prescriber conservatism and possible concerns around affordability or adherence. Importantly, the disproportionate reduction in diastolic versus systolic pressure observed in our cohort further supports the need for personalized pharmacologic strategies, especially for older adults with isolated systolic hypertension.

Effective hypertension control requires more than pharmacological intervention. Structured patient follow-up, access to consistent medical supervision, and education around lifestyle modification must be integrated into routine care. The attrition noted at Day 30 suggests that even within tertiary centers, logistical barriers and limited patient engagement hinder long-term outcomes. These findings underscore the need for reinforcing guideline-based prescribing, ensuring regular monitoring, and incorporating individualized care approaches. Future work should also explore how digital tools and low-cost monitoring interventions can support better adherence and follow-up, particularly in resource-limited settings.

Despite the strengths of this prospective observational design, several limitations should be acknowledged. First, although the sample size of 222 patients was sufficient for preliminary analysis, the recruitment from a single tertiary care center may limit the generalizability of findings to broader or more diverse hypertensive

populations. A more heterogeneous sample across multiple centers could offer greater insight into demographic variability in treatment response. Second, the relatively short follow-up duration restricted to 30 days provides only an initial snapshot of blood pressure trends. Long-term studies are needed to assess the sustainability of BP control and detect delayed therapeutic effects. Additionally, reliance on self-reported adherence introduces the potential for response bias, as patients may overestimate compliance due to social desirability or misinterpretation of their medication regimen. Employing objective measures such as electronic monitoring or pharmacy refill data in future studies would enhance data reliability. Furthermore, the absence of a control group precludes definitive attribution of BP changes solely to the prescribed therapies. Randomized controlled trials are necessary to establish causality. Lastly, the variation in prescribed drug combinations, in the absence of a standardized treatment protocol, may have influenced therapeutic outcomes. Future studies adopting uniform treatment guidelines could yield more consistent and interpretable results.

Conclusion:

Antihypertensive drug therapy remains central to managing hypertension, particularly under the revised diagnostic threshold of 130/80 mmHg. In this study, while blood pressure improved over 30 days of therapy, 92% of participants did not achieve target systolic control, underscoring the persistent challenge in clinical practice. Given hypertension's role as a major risk factor for cardiovascular diseases, kidney dysfunction, and stroke, optimal BP management is critical for reducing long-term morbidity.

Tailoring antihypertensive treatment to individual patient characteristics including comorbidities, treatment history, and risk profile is essential. Furthermore, consistent medication adherence, regular follow-up, and lifestyle modification must be emphasized to achieve and sustain therapeutic goals. With a combination of evidence-based pharmacotherapy, behavioral interventions, and health system support, substantial progress can be made in reducing the burden of uncontrolled hypertension.

Conflict of Interest: None declared

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